Thesis/
Reports
Levi,
D. J.

METHODOLOGIES FOR COMMUNICATING TECHNICAL SCIENTIFIC INFORMATION PERTAINING TO NATURAL RESOURCE MANAGEMENT

Methodologies for Communicating Technical Scientific Information Pertaining to Natural Resource Management

Cooperative Research Agreement RM 16-751-CA

FINAL REPORT

Daniel J. Levi, M. Joyce Shettel-Neuber,

and Terry C. Daniel

University of Arizona

Principal Investigators

Terry C. Daniel

and

William H. Ittelson

University of Arizona

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION

When attempting to decide how an area of land should be managed, forest land managers face a difficult decision-making situation. They must consider complex interrelationships among many different social and biological factors and resources. At the same time, they must consider the desires and values of their various public constituents. If these constituents are to participate effectively in the land management decision-making process, these complex interrelationships must be communicated clearly to the involved public.

Land management planning is a process for deciding about how the land will be managed. As in all decisions, options or alternatives are available. The ultimate decision is a choice of one alternative which is usually a compromise of a set of several alternatives which have been compared. The planning process requires the development and comparison of several alternatives in order to present the management trade-offs to decision-makers.

Trade-offs are the result of scarcity and are characterized by what economists call competitive relationships. The trade-off describes a relationship between two or more desirable effects or outputs where more of one of them requires that there be less of the other. Clear presentation of trade-offs is important to the manager and to the public because they are frequently the critical distinguishing feature between alternatives.

Forest management invariably effects many interrelated factors, e.g., trees, grass, water, wildlife, recreation opportunities, etc. Because of this complexity, the full range of alternatives in a land management planning context is rarely examined. Rather, discrete alternatives are formulated. The effects of these are estimated and the

alternatives are compared. The alternatives cannot be so numerous that decision-makers are unable to assimilate all the information. The most important differences between the considered alternatives are generally the trade-offs among various social, economic, and biological effects or factors.

How should these trade-offs be displayed to best communicate the important differences between alternatives? All of the considerations traditionally of concern in any communication are relevant, including the characteristics of the audience, and the purpose of the communication. The communication of trade-offs however, has the added difficulty of increased complexity and the need to make the audience aware of the interrelationships among the specific benefits and costs within and between alternatives. Further, these effects are usually represented in a technical, quantitative format.

The problem of the complexity in the presentation can be handled in a number of ways. Limiting the number of alternatives presented and the number of factors which are considered within each alternative is a good starting place. The amount of information must be simplified, while still presenting the trade-offs involved in the decision. This is, of course, much easier said than done. Even with most careful presentation, the trade-offs in the comparison of the alternatives may be ignored by the audience. Rather than appreciating the trade-offs among resources which are the reason for the differences among the alternatives, the audience of the communication may select their own favorite parts of each of the alternatives without considering the trade-offs between these factors and other important resources or uses. Intentionally or unintentionally, people often focus on only one or two factors as the basis for their decisions while ignoring other implications or trade-offs

required by their choice.

In order to deal with this problem, the land manager must make the audience aware of the trade-offs represented by each alternative. A good approach is first to use an example of a relatively straightforward trade-off between two factors (such as timber production and range use). This helps to alert the audience to the presence of trade-offs and to their implications in the decision process. This example could be followed by a presentation of the specific trade-offs among the factors currently under consideration. In some situations, it may be possible to show how the various alternatives were constructed in an attempt to balance trade-offs in key factors. Another approach could be to construct the alternatives one factor at a time to show how trade-offs influenced their development. However achieved, it is the responsibility of the communicator to make the audience aware of these trade-offs and of their role in each of the alternatives under consideration.

In the following pages, different approaches and techniques for communicating forest management information are discussed. Following a brief discussion of more general communication issues, examples of specific techniques will be presented with particular attention to their applicability for communicating trade-offs.

Communication Issues

The value of information gathered by the forest manager and his staff depends greatly upon their ability to communicate that information to other professionals, and to the public. Successful communication requires the translation of quantitative, technical information into a form that can present the relevant aspects of that information to a specified audience.

While this discussion will consider only printed media, there are a large variety of methods or techniques available for communicating technical information. A number of books discuss the relative merits of narrative text vs. various graphs, charts, and tables. The evaluations of these techniques, however, are based almost entirely upon personal observations and preferences. There is little systematic or objective information by which to judge the relative effectiveness of various techniques or the appropriateness of each technique for specified tasks.

While a background of systematic research detailing the differential effectiveness of various communication techniques does not exist, it is possible to compare and evaluate methods based on more general guidelines for their use. These guidelines can help to identify important qualities which affect the selection of an appropriate method. The primary questions which determine the selection of a particular method or set of methods are:

1) What is the nature of the information to be conveyed?

2) Who is the audience that is to receive the communication? and

3) What is the purpose of the communication?

Content -- The knowledge or information to be covered by a communication will determine to a large extent the form in which it is presented. Forest managers must frequently attempt to communicate highly technical information. This specialized, technical information may be meaningful to other managers or scientists with similar backgrounds, but it may appear completely unintelligible to more general audiences.

The most pertinent information for forest management decisions usually consists of measured attributes such as the amount of standing timber or annual volumes of water released. In most cases, forest management

depends upon the interrelationships or trade-offs among many such variables or factors. Each variable may change over time for each management alternative, and each factor will have some effect on the other factors. Communication methods, then, must facilitate the comparison of different actions in terms of changing patterns of effects. Graphs and charts of various kinds are the most likely candidates. There is a real danger, however, that presenting many related effects in these formats will require a level of complexity that exceeds the comprehension capabilities of many important audiences. An acceptable compromise must be made between presenting too little information, thus hazarding misrepresentation by omission, and too much information which may be complex and confusing, thus reducing comprehension.

Whatever the amount of information presented, communications can vary in clarity or complexity. The use of bureaucratic jargon, technical terms, and long convoluted sentences will make the simplest of information appear more complex. The use of statistics and other mathematical manipulations within a communication may not only be confusing, but may also make the non-technical reader anxious and distrustful. In sum, the communicator has a responsibility to present his information in as readable and attractive a manner as possible. At the same time he must balance this goal against the need to provide a complete and accurate presentation of the "facts." Any communication will necessarily be a simplification and generalization of the detailed information available. The communication must, however, convey the principal meaning contained in the original complex array of quantitative and technical information.

One of the ways which communicators attempt to resolve the conflicting goals of completeness vs. clarity is to use synthesized information or composite indices. Although this can be a valid approach, it presents

many problems and hazards. Combining or synthesizing information can obscure important relationships among individual factors. The new, composite factor may take on a different meaning for the audience than had been intended. The presentation or communication may appear simple and clear when, in fact, the most relevant issues have been hidden or lost in the synthesizing process. If synthesized information or indices are used, their meaning should be carefully stated. Generally, it is better that factors not be combined until late in the communication process, after the individual factors have been described.

Another information content concern is validity or certainty of the information to be communicated. Measurement instruments differ in their reliability, sensitivity, and validity. There are differences in the amount of consensus among professionals about how measurements should be made and the value and interpretation that should be ascribed to the resulting information. In many cases, there is also uncertainty caused by incomplete or missing information. For planning issues, projected or simulated information is often very relevant, but its validity is dependent upon a number of assumptions and models that are not perfect.

Regardless of the care which a forest manager uses to obtain his information, he will always be dealing with uncertainty. When communicating this information, some indication should be given of the degree of this uncertainty. This does not mean that every bit of information presented should include statistical confidence levels or elaborate discussions on the measurement methodology; this would only confuse the audience. However, simulated information should be labeled as such and areas of uncertainty should be specifically noted.

The cost of presenting information must also be a consideration. Through the use of computers and video systems, a large number of

communication options are available; however, the cost of using these communication systems is often prohibitive. This report will only consider "hard copy" communication techniques or methods which can be easily reproduced and distributed to public audiences. These are the communication methods which are most in use in forest management and public involvement.

The purpose of this discussion has been to examine the nature of the information in a communication. The main issues, in one sense, are to determine what is the relevant information and how it should be presented. In order to answer these questions, one must examine to whom the information is being sent and for what purpose.

Audience -- The basic purpose of communication is to convey information from one individual or group to another. The communication must, therefore, be in a form which is usable and meaningful to the receiver. Because individuals differ in their training and experience, communications must be specifically structured for the audience to which they are directed.

In preparing information for communication to an audience, it is important to assess the characteristics of that audience. One approach is to categorize the audience according to its size and location. This geographical division will set certain limits on the communication. A local audience, for example, may be expected to know the location of places referred to in the communication while a national audience may require a map and some description of the setting referred to in the communication. A local audience can be asked to call or come to a meeting if they have any questions, but a national audience will have considerable difficulty contacting the communicater in order to clarify points in the communication. Geographical area also places limitations on the type of

communications media used: local audiences may be small and close enough to contact by phone, while national audiences will require mailing or the use of mass media. Although geographical location of the audience does affect the selection and form of a communication, the importance of this audience characteristic is often overrated while more important factors are overlooked.

Another common method of categorizing audiences is according to the types of groups to which they belong. This usually involves separating the audience into three groups: the general public, special interest groups, and professionals such as managers, planners, and scientists. Although this is a valuable way to characterize audiences, it is often too gross a classification to allow adequate tailoring of communications.

Two important audience factors or dimensions that should be considered in communications are interest and sophistication. The degree of sophistication of an audience will affect their ability to comprehend and deal with the material presented. Technical terms, mathematical analysis, complex graphics, and other types of presentations may be appropriate in professional publications but are usually inappropriate for communication to the general public. In a sense, technical information can be directly communicated to a highly sophisticated audience, while it must be translated for an audience which is less sophisticated.

Though generally sophisticated and highly educated, an audience may, nonetheless, be low in sophistication regarding some particular forest management issues. Such groups will find it helpful to have new information related to more familiar contents, thus facilitating assimilation of the unfamiliar contents of the communication. Audiences with generally low sophistication may require a more extensive simplification of the material, perhaps relating it to everyday events. Among any audience

there will be some members who have considerable knowledge related to forest management issues and who will be familiar with most of the concepts and terminology. These individuals are relatively rare, however, and are not usually the targets of general public information and involvement programs.

Level of sophistication is related to the other audience classifications. The general public, for example, may be relatively low in sophistication, while professionals are relatively high in sophistication. Special interest groups often have considerable sophistication in specific areas, but not in others. Since special interest groups and the general public are often mixed together on mailing lists, it is usually best to assume a lower level of sophistication, and make more sophisticated presentations of the material available upon request.

Groups and individuals also vary on the amount of interest they have in the information which is being communicated. Some groups may be intensively interested in specific issues (such as wildlife or water), but may be relatively uninterested in other contents of the communication. The level of overall interest does not neatly vary with the type of group; however, area of specific interest likely will relate to special interest groups and professionals.

Purpose -- The two main purposes of Forest Service communications are to inform and to involve. To inform requires presenting information so that the receiver is made aware of and more fully understands some situation. Meeting involvement goals requires mechanisms that allow the receiver to communicate his reactions, opinions, and preferences back to the sender.

To inform an audience a communication must effectively present the decision or management situation and its context, and describe the main

goals and constraints that will affect the ultimate actions that will be taken. The presentation must be clear, concise, and meaningful to the audience. The tone of the presentation should be objective and factual. The content and presentation method should not favor one opinion or approach, but should uniformly represent the positive and negative aspects of all of the options. The goal is to educate the audience so that they can come to a reasonable decision about the situation.

Frequently the goal of a communication is not only to convey information, but to elicit reactions or comments from the audience. Whenever the opinions or judgements of the audience are sought, the communicator must decide what type of information he wants from the audience, and structure his communication accordingly. The characteristics of the target audience will affect the type of information that will be returned but the form of the communication also has very important influences on the responses.

Many communicators are technically trained individuals who routinely deal with technical information and abstract concepts. If it is assumed that the audience is similarly trained, then factual information and a discussion of the relationships among abstract concepts will be expected as responses. More often, though, audiences are not technically sophisticated and they provide subjective opinions, values, and feelings instead. The communicator will be disappointed, in this case, and may come to the conclusion that the audience has nothing of value to say about the important issues that were presented in the communication.

General audiences do not usually consist of technically trained individuals. Although they may share the same opinions with a more sophisticated group, they will express their opinions in a different manner. The communicator must respect these opinions and learn to incorporate

subjective preferences, values, and feelings into his analysis of the audience's response. There are a variety of techniques, such as content analysis and Codinvolve which can be used to facilitate such an evaluation of responses.

Another common assumption about general audiences is that they are best presented with questions about very general goals and issues. Concrete issues are viewed as too technical and too specific. This approach often results in the presentation of abstract terms, without adequate reference to the actual factors influencing the situation. Relegating public responses to very general, abstract goals and concerns almost assures that their reactions will not be useful for real decisions. The public should not be asked whether they want wilderness areas; they should be presented with the existing conditions in a specific area and asked whether wilderness designation is desirable, how large it should be, and where it should be located. Response to these questions can be more meaningful and more useful to conscientious managers.

Whenever a response is desired from an audience, some format for the response must be provided. The format should be easy for the audience to use and designed to facilitate the communicator's task of recording and analyzing the replies. It may be best to use a variety of response formats and to distribute them throughout the presentation, perhaps asking the same basic question in several different ways. This gives the audience a range of alternative ways to comprehend and reply to questions.

Communication Technique

There are many means for communicating information to groups. Some of the most effective include verbal (oral) presentations, radio and television, slides, films, and videotapes. While these techniques can be quite effective, they may require substantial financial and technical

resources to produce. The current report is specifically concerned with "hard copy" presentations, so the relative merits of these other techniques will not be discussed. Instead the focus will be upon hard copy techniques which lend themselves to reproduction in booklet or flyer form, suitable for distribution by mail or hand delivery. Specific techniques include written narratives (prose), tables and charts, pictures, maps, games, and models.

Written Prose -- Presentation of material in prose form is one of the most successful methods of communicating information. Citizens with an average amount of education are used to dealing with printed information and are able to synthesize basic facts from prose. Written material is flexible in that the level of difficulty of the text can be varied to suit the material presented and the level of sophistication of the audience. Written material does, however, have some drawbacks. If there is a large amount of information to be presented, lengthy prose presentations may discourage the target audience from reading the material. Reliance on written text to describe and compare a variety of management plans can result in long passages, making it difficult for a reader to comprehend and evaluate the information presented. Comprehension can be improved by techniques such as underlining major concepts or passages within the text and isolating major points of comparisons among plans. Also, important concepts can be extracted from the written presentation and organized into an accompanying chart.

Another difficulty in presenting material in prose form arises when the content of the communication contains a large amount of quantitative information. It is difficult to read figures or measurements when many of them are interspersed in a narrative text. This type of information is much more easily comprehended when presented in a condensed form, such

as a table, or graph. Most often the combination of prose and tabular or graph format is most appropriate. A table or graph can summarize basic information and group it for easy comparison, while a parallel text explaines and elaborates the important concepts.

With the growing reliance on television and radio for gathering knowledge about the world, the interest in and use of printed material is declining. Also, the barrage of printed advertising that citizens receive in the mail is becoming staggering. Therefore, to be effective it is necessary to present material in such a way as to convince the citizen that the information contained is worthy of the time required to read and comprehend it. A lengthy written pamphlet would not meet this criterion for the majority of the public audience. The use of graphic techniques to catch the reader's attention and the condensation and organization of material into a short efficient form will help to insure that a larger portion of the potential audience will be affected by the communication.

With regard to the use of written material in the presentation of forest management problems, some general conclusions can be offered. The content of such communications tends to be technical and to contain large amounts of quantitative information. Some written prose will be necessary to explain the context of the problem and to clarify technical concepts. This text should, however, be accompanied by summaries of the main points in some condensed form, such as underlined statements, lists of points, or tables or charts. If the purpose of the communication is to solicit information from the public, the communication should be brief and condensed. When a communication is interactive, the time required for comprehending and for responding both need to be considered. If comprehending the information will require a substantial amount of time, the means

for responding should not require such a time commitment. If the recipient is required to read a lengthy description of several different forest management policies, he should not be required to evaluate these policies in written essays. In many cases, the time and energy required to complete such a task would dissuade potential respondents. It may be wise to provide the respondent with some graphic means to make his response (such as indicating areas on a simple map, or marking points on a graph) or to provide written responses from which he may choose.

The characteristics of the potential audience will also influence the form of written material. Depending upon the interest and sophistication of the audience, the tone of the prose can be adjusted. If the group is one which has a high specific interest in the topic, but a relatively low level of technical sophistication, the prose should be simplified for understanding and should emphasize the aspects that are of importance to this particular group. If the material is being presented to a less selected group, such as city residents, individual members may be characterized by all categories of interest and sophistication. In this event, it would be most appropriate to write the prose explanation of the material on a level which could be understood by all members of the group. If it is important to obtain information from the more sophisticated members of the audience in more detail, that information should be obtained in a separate communique or in an "optional" appendage to the simpler communication. If the group is also mixed in their degree of interest (specific or general), it may be wise to include incentives for completing the questionnaire which appeal to several types of interest. Statements pointing to the general importance of forest conservation and more specific statements regarding particular affects likely to be of interest to segments of the group (e.g., wilderness preservation, recreation, water

should be included.

Written prose has an important role in the explanation and presentation of trade-offs. Regardless of the communication method used to present trade-offs and alternative plans, written material is necessary to explain the concept of trade-offs and to show the trade-offs which occur within and among the alternative plans. Written prose can also be used to present the alternative plans, but it should be accompanied by some form of summarizing graphics that allowss easy comparison of alternatives in terms of major factors.

When writing is used to present alternative plans, it is important to avoid biasing the presentation and to make the descriptions comparable. Although the importance of making the presentations equitable to avoid biasing may appear obvious, biasing effects within a presentation may not be obvious. Figure 1 contains two examples of written presentations of alternative plans: the first example is more typical while the second is a more rigorous format referred to as a comparative description.

Insert Figure 1 about here

The comparative description technique is a formalized writing method which emphasizes the use of a systematic presentation of material with comparable descriptive terms. The comparative description technique allows a systematic comparison among alternatives. It avoids biasing effects due to the sequence in which factors are presented and due to the length of presentation and type of descriptor terms used. Comparative descriptions require that each is described in terms of a common set of factors. This technique, then, combines some of the readability of written prose with the objectivity and structure usually found in tables or charts.

Written prose will continue to be an essential part of any public communication. Care must be exercised, however, to insure an unbiased presentation of information pertinent to decisions and issues under consideration. When technical, quantitative information is important, prose presentations will be more effective when combined with tables, charts, or other graphic methods.

Tables/Charts -- Charts and tables are convenient ways to summarize information. It is possible to present information in enough detail that the condensed form is all that is necessary for communication. More often, however, charts and tables accompany a more complete written communication.

Tables generally present quantitative material in a condensed form. It is possible, thus, to list the various values of a certain measurement across categories. For example, a table could be used to present how the outputs of resources change across a set of alternative plans as in Figure 2.

Insert Figure 2 about here

Although a table like that in Panel A presents the information needed to consider the trade-offs among the plans, only a highly sophisticated audience would be able effectively to use such a table. Even with a written text to explain the alternative plans, the table is difficult to interpret because of the differences in the units used to measure the factors. The primary (and very limited) value of these technical tables is for professionals who have specific interest in and familiarity with the quantities indicated, Panel B presents a table that is likely to be more informative to general audiences. Specific numerical quantities are replaced by "significance" levels. Now the units for each factor

listed are comparable, and the amount of change in each is interpreted in a more meaningful way.

Charts are more flexible than tables and may contain both written and graphic material. They provide an excellent means for condensed presentation of information. When used in the presentation of trade-offs in alternative plans, charts have the same basic limitations as tables. Attempts to present too much detailed information will make a chart very hard to read. As can be seen in the following example, some trade-offs among plans can be clearly expressed in a chart.

Insert Figure 3 about here

The flowchart is an increasingly popular graphic communication device. Flowcharting employs a system of symbols that have universal meaning. A flowchart system has a definite beginning and proceeds through a series of processes, decisions, and manipulations to any number of possible outcomes. Flowcharts are very useful in indicating any type of sequential actions or decisions. While flowcharts may be complex, it is possible to present a simplified flowchart which is understandable to audiences with relatively low levels of sophistication. This is due to the fact that choices and paths are clearly presented within the flowchart format.

The flowchart is typically based on a yes or no type choice. When a decision block is encountered, it is necessary to make a decision and then proceed along the path dictated by the choice. This limits the ability to present the concept of balancing or trading different amounts of one entity for another, such as accepting a slight decrease in air quality to obtain more jobs for a region. Through a series of loops it would be possible to compare the various elements in a system and obtain

a priority listing, but the resulting chart would be quite complex. The simple flowchart does not express variability in amounts of options, and the design of a flowchart with a variety of amounts would become quite complex.

The use of charts and tables within the text of a presentation is a useful way of separating and summarizing important points. For some types of information, tables and charts may be used to present information without accompanying written descriptions. This use of tables or charts is more restrictive in the amount of information which can be included and may not be as useful for the presentation of highly technical material due to the required complexity of the chart to present the information. For the presentation of trade-offs in forest management, the use of charts and tables is probably best as a way to summarize information after it has been discussed in a written presentation.

Photographs, Drawings, and Cartoons -- The earliest means of printed communication, and one which is still one of the most powerful, is the picture. Most researchers agree that the use of pictures can be extremely effective in presenting information. Research has shown that information presented with pictures is more accurately and consistently comprehended by people than the same information presented in printed form. While most pictured information is readily interpreted by people, the degree of realism portrayed varies with the type of picture.

Photographs are the most realistic representation of a visual concept. They are very useful in portraying what might be seen in the situation represented. In presenting forest landscapes which might be affected by some program, for example, it would be possible to provide an accurate view of the forest with photographs. Photographs are limited,

however, in that they require selection of a specific viewpoint for the subject, and they are generally restricted to portrayal of landmarks or objects that are within the field of view. Although it is possible to produce composite photographs to combine features, it is generally very costly and tends to counteract their property of portraying things as they look to people in reality. Photographs do provide a good deal of flexibility since it is possible to produce black and white, realistic color, or non-realistic effects (such as color reversal). Some research suggests that comprehension is facilitated by the use of realistic color visual material, but it is not conclusive and study of the usefulness of the other techniques remains to be conducted.

Photography is a very useful medium. Most people respond favorably to photographs both in interest and comprehension. Photos provide the best means of portraying the visual environment as the eye sees it, and they permit flexible use of techniques such as overlay and monotone printing. Photography can be less flexible in the portrayal of multiple environmental features. Another concern in the use of photography is cost. Depending upon the number of photographs required, the number of copies of each, and whether color or black and white pictures are desired, production costs can be rather high, or quite modest. However, with modern color reproduction techniques, the use of realistic color pictures has become much more economical than in the past.

Drawings or renderings can be very useful methods of presentation. Drawings can vary in their degree of reality, and allow the artist a great deal of flexibility in what he includes in a drawing. While a photograph can be restricted to one viewpoint, a drawing can include several concepts. If an artist wishes to suggest the effects on timber, range, water, recreation, wildlife, jobs, and wilderness potential of a

forest management plan, he may include all in one drawing. The artist may choose to represent these features symbolically, such as using a deer as the symbol for wildlife. In comparing different management plans, he could alter the symbols, such as removing wildlife, altering river levels, and thinning timber stands. While a complete description of the plan could appear in written text, the visual representation would summarize the major features. If a more detailed pictured explanation were desired, each aspect could be presented in a visual sequence.

Drawings are helpful in their adaptation to the specific task. They can be printed in realistic simulated colors and suggest the actual appearance of an area or can serve as symbolic representations. Subject matter included is controlled by the artist, and generally the cost is less than photographic presentation. The degree of reality represented can be varied to suit the desired task, and the audience is still generally able to comprehend the subject matter.

Insert Figure 4 about here

Cartooning, while frequently suggesting a humorous interpretation, is drawing which abstracts realistic portrayal. While drawing can be varied along the reality dimension, cartooning is at the abstract end of the dimension. It is a useful medium for attracting an audience's attention. For example, if one wants to present an average forest user, it can be effective to present "Joyn Q. Public" in a cartoon form rather than a photograph or a realistic drawing. This allows an abstract representation with which it is easier to identify, and that can be made sexless and without cultural reference. While cartoon figures are sometimes presented in a realistic setting, it is more common to see the consistent use of one style.

The use of visual representation can hardly be an error. It is generally accepted as a medium capable of eliciting audience interest and understanding. The extent of its use and the degree of abstraction can be related to the nature of the material and to audience characteristics. If the material is technical, it would be effective to combine prose explanations with visual representations. It is difficult to present technical details in pictures or photographs. The combination of written passages and pictures, however, serves to clarify concepts while presenting details.

Pictures are a valuable technique for presenting trade-offs especially to audiences that are not highly sophisticated. They can be used to show the relationship between two or more factors in a manner which visually demonstrates the interrelationships among the factors. Pictures are probably best used as a visual example for a written presentation on trade-offs. There are problems with trying to use pictures to characterize an entire alternative plan. The portrayal of too many factors simultaneously will obscure rather than highlight the trade-offs. Such a presentation could be open to biases due to artistic differences among the composites.

Insert Figure 5 about here

Pictures are generally interest-inspiring. In choosing the degree of abstraction of a picture, however, audience sophistication level should be considered. Cartoon portrayals may not appeal to an audience that is highly sophisticated or intensely interested about the topic. Pictures high in realism or with moderate abstraction are generally regarded as best for general audiences.

Maps -- Maps can provide a means of relating a specific area to its surroundings. If the area is part of the audience's community, a map provides specific location. If the concerned area is unfamiliar or hypothetical, a map helps the audience see the interrelationships among features of the area. Thus, if a timber stand is on a ridge and its harvesting will affect land below it, a map will indicate aspects of the adjacent areas which will be affected. A map can help convey the extensiveness of possible management effects. If one plan affects 30% of a wooded area and another affects 50%, maps can be helpful in showing these relative percentages. Maps are understood by most audiences; even young children are generally able to view and comprehend simple maps.

Maps are a valuable technique for presenting trade-offs when the trade-offs relate to geographic areas. They also can be useful in showing the spatial relationships among the parts of alternative plans. Usually, a written text is required to explain the purpose and trade-offs in a map. Like most presentation methods, the value of maps decreases if the situation being presented becomes too complex. A series of maps in which each map portrays a single trade-off issue or alternative plan (Panel A in Figure 6) is usually better than a composite map trying to portray a variety of alternatives (Panel B, Figure 6).

Insert Figure 6 about here

The content and purpose of a communication will indicate whether the use of a map is appropriate. If a specific location needs to be identified, a map is appropriate. Also, if a forest management plan requires a knowledge of the location and proximity of certain areas, a map is appropriate. In many circumstances a map can be one of the most effective means of communication.

Graphs -- Graphs are a convenient means of representing quantitative information in a concise form. Instead of spreading numbers throughout a text, it is helpful to have numbers to be compared in one location. The graph allows a visual means of comparing the magnitudes of different measures which may not be as clear in a written description.

Special care should be taken in construction of graphs if an objective presentation is desired. Graphs lend themselves to distortion and manipulation of actual magnitudes. By abstracting a portion of a graph, using symbols which magnify an effect due to a larger area, or departing from linearity on an axis, it is possible to distort the values presented.

While graphs are convenient for condensing relative measures, they in themselves do not represent the causes behind the effects. If information that is dramatic in its graphic impact is to be presented, but the effect does not seem as dramatic when explained within the context of the situation, care should be taken to insure that the qualifying information will be considered by the audience. Due to their ability to condense information, therefore, graphs encourage an audience to study them and gloss over qualifying information which may accompany them. If graphs are used, they should reflect the major concept of the information presented so they are meaningful and accurate in their own right.

There are a large number of types of graphs which can be used to present forest management information. Some examples of these are presented on the following pages. The absence of systematic research does not permit an evaluation of these types. However, the way the graphs are used may be more important than the specific type of graph which is selected.

Graphs are a useful way of presenting the relationship among a number of factors, but they do not necessarily present trade-offs. The

trade-offs among factors or alternative plans needs to be noted in an accompanying text so that the audience is aware of them in the graph. The use of a series of graphs to portray the mix of factors in alternative plans is usually better than a composite graph because of the difficulty in interpreting the composite. However, the serial presentation may encourage the audience to consider only one or two factors in comparing the alternative plans.

Insert Figure 7 about here

One approach which combines the serial and composite methods is the factor profile. The factor profile is a graphic portrayal of the comparative description method discussed previously, and these two methods should probably be used together. The technical features of a factor profile have been discussed elsewhere. Although this method is a good way to present and summarize alternative plans, it will usually require both an explanation of how to interpret and a discussion of the trade-offs which are shown in it.

Insert Figure 8 about here

For the specific task of conveying information regarding forest management plans to the public, the graph is a worthwhile technique. The graph is useful for presenting relative magnitudes on the same axis, therefore making it possible to present the effects of several plans on several aspects of forest management. Care should be taken, however, to avoid distortion of the quantities represented and also to avoid a figure that is too complex and difficult to read. Especially for the less sophisticated or low interest audience, a graph that requires a long time to decode will not be effective. Given these considerations, graphs can be

very effective in presenting the type of information necessary to compare methods of forest management.

Games -- The game format is one which can be effective in a communication system which emphasizes interaction. Since this approach is not frequently used, it can stimulate interest in the task. However, the game should not be so intricate as to appear to require even more time and trouble than a more conventional format, such as a questionnaire. Unless it appears to be a useful approach to a specific problem, it may strike an audience as childish or a waste of effort.

A type of game that is particularly appropriate to the solicitation of opinions regarding forest management options is the trade-off game. In this game participants are required to make an overall decision which requires the balancing of a combination of components. For example, the task might be to choose the most appropriate forest management technique. The participant would be given information about a number of necessary components to the system, such as timber, range, water, recreation, wildlife, jobs, and wilderness potential. He would then be given some unit of measurement, such as a budgeted amount of money, and the corresponding costs and benefits of each of the components. He would then be asked to make up a program which meets the budget requirements while achieving the best balance among the component parts.

Trade-off games do require a large amount of structuring by their creator. In order to force a decision as to relative proportions of various components, it is necessary to use some sort of overall measure, such as money or "points," which applies to all components. The selection of this common measure is frequently the most difficult aspect of creating a game and often does not yield a satisfactory outcome. It is difficult to compare vastly different entities on the same scale. For

example, the market value of timber can be assessed in essentially real dollars, but scenic values do not readily lend themselves to a dollar assessment. The costs of jobs and wilderness potential are not necessarily comparable along the same dimension. In order to structure a trade-off game, however, it is necessary to provide some common dimension on which to compare components and to establish some limit on the total costs and gains possible for any plan. The structuring of the game by the creator also has the effect of limiting outcomes to those that he can conceive. If the participant is to have some creative potential, the trade-off game may not be flexible enough.

Another type of game can be fashioned so that the participant makes a decision and proceeds from there. For example, he might be given a series of forced choices which determine his progress. On a board game, he may draw a card which forces him to choose between recreation and wildlife and then follow a path which asks him to make further choices as to which of certain pairs of components are more important in his opinion. In this manner, a hierarchy of components could be constructed and he would end up at a location on a path corresponding to a certain management plan reflective of these choices. Again, this requires a great deal of structuring on the part of the creator and may make certain choices more forced than they would be in an actual decision situation. They, however, do provide for an ordering as to the perceived importance of certain aspects of an overall plan. From this type of game, general information as to the relative importance of each component could be gathered and considered as guides to actual specific decisions.

Games, then, can be very useful in interactive modes of communication. Since the material is structured, the results lend themselves to generalization and quantification. Possible results are limited to those

which the creator has preconceived, however, and some allowance for additional outcomes may be appropriate. The game format can be an attractive way of eliciting interest in a particular subject, but should not add to the complexity of the task at hand. A four-page mailer filled with a myriad of paths and symbols would probably be received less favorably than a four-page questionnaire, as the game format requires extra time just to understand the task while the questionnaire is a form familiar to most. The presentation of the game as worthwhile and meaningful is necessary. Also, if the audience is at a high level of sophistication and interest, the game should not appear to make light of the topic. If it is presented as "The Forest Game," it could give the impression of being a childish interpretation of a serious subject. Consideration of the audience's level of sophistication and interest, therefore, would modulate the manner of presenting the game.

Models/Simulations -- Another way to present information is by means of a systems approach. This particular technique is concerned with replacing or simulating a real-world situation about which a participant is asked to make decisions. In the case of forest management, the forest environment would be the subject of simulation. Creation of a model or simulated forest environment would provide a mini-environment in which to test and/or demonstrate the effects of certain policies and changes.

Systems representations can take several forms. Computer simulations have become quite popular recently. In this approach the computer is programmed to produce an effect depending upon the action or event which takes place within a total system which has been programmed into the computer. For example, in a simulated natural environment the computer may be programmed to indicate erosion in a hilly area if information is entered that a heavy rainfall has occurred. The use of computer

simulation presents problems for the forest management example. A simulation of a forest environment requires an extensive data base, which may not always be available. Also, since individuals would generally not have direct access to a computer terminal, the interactive capacity of the computer could not be used to its fullest advantage. Some "hard copy" or printout of computer simulations on a variety of effects would have to be provided to individuals. This restriction would reduce many of the advantages of simulations. In the future, with an increased availability of terminals, the computer simulation may prove very useful.

Reduced scale models can also be used to simulate events in the real environment. This requires a physical manipulation of the various parts in the model and can be useful in helping to demonstrate the physical effects of a particular plan. By observing the condition of the model, one is frequently able to imagine how the actual environment would appear after the implementation of a plan. In utilizing this model approach for a hard copy campaign, it would be possible to manipulate the model and take photographs of the various conditions after the implementation of forest management plans. The time and cost of producing models,

---

Insert Figure 9 about here

---

and the additional costs of manipulating them, would have to be seriously considered if this model were to be used. It might not be considered worthwhile to produce an elaborate model which could only be used in regard to a single area. The more flexible the model board in representing various areas, the more feasible this approach.

Although not as easy to view and comprehend, a systems approach can also be presented on paper. Through the use of charts which indicate the interrelationship between various parts of a system, one is able to

trace the effects of certain actions through a system. The major drawback to such an approach is in its complexity. Unless the audience is classified as having high interest and sophistication, they may not be willing to spend the time needed to become familiar with the method of presentation. A less interested and sophisticated audience may not be able or willing to become involved with tracing the effects of several approaches through a lengthy system.

Because models and simulations are based on a systems approach, they have the potential to be used to portray why a trade-off exists and how it operates. In the future, various types of simulations may be important methods for communicating the trade-offs in forest management decisions. Unfortunately, the current problems with communicating these models and simulations limit their usefulness in most situations.

While the simulation approach has the advantage of presenting a miniaturized version of an actual environment which can be manipulated to approximate actual changes, it also has the drawbacks of requiring high costs and time investments and the need for a sophisticated audience. The use of photographs of effects represented on models would probably be the most versatile application for most audiences, if this method could be made cost effective.

Communication Quality

Color vs. Black-and-White -- Virtually any presentation is enhanced by the use of color. It is much easier to catch the attention of a potential audience with a color reproduction. Depending on the method of presentation chosen, its use can have different effects. Color used with photographs or drawings helps to clarify the presentation of the subject. It can be used in natural colors, as in drawings or color photographs, or to code certain objects or concepts, such as the consistent coloring of

figures throughout a series of drawings. While naturalistic color has been shown to be more effective than non-realistic color for certain presentations, the use of non-realistic color, such as reverse images, can be very attention-arousing.

Color can be used with written presentations to clarify the presentation. The use of colored ink on certain words helps to emphasize them. Color coding can be very effective also. If several methods of forest management are to be presented, the color of ink used can be consistent throughout presentations (such as the use of green ink for written passages, map details, and graph bars which refer to Plan A). This helps the participant differentiate between the various plans and transfer from one method of presentation to another.

Aside from the additional costs necessary to produce material in color, the use of color in hard copy is desirable. Obviously, an excess of complexity as to color use and its significance can be negative. Color should be used to enhance, clarify, and arouse interest, not to complicate and overwhelm.

Static/Dynamic -- The degree to which the communication is static or dynamic is dependent on the purposes and content of the material to be communicated. For presenting various methods of forest management, the dynamic nature of the content suggests that the presentation should be dynamic. The material is concerned with change over time caused by the implementation of plans. Techniques should be used which portray this dynamic quality to the audience.

With written material, changes across time can be described, presenting both current effects of a plan and long range implications. If an audience is being asked to evaluate alternative plans, it should be clear which outcomes are to be evaluated. Some plans may be more

advantageous at the present time, but long term effects may be less favorable than those of another plan whose benefits are longer in coming. It must be clear whether immediate, long-term, or both implications of plans are to be considered by the respondent.

Photographs, or drawings are helpful in expressing dynamic situations. A photograph or drawing can retain one perspective of a scene while varying conditions within that scene. A series of pictures can represent the sequential effects of various plans. Also, the use of overlays can be very effective with photographs or pictures. In the overlay technique, a basic photograph or drawing is progressively modified by the overlay of plastic plates. The features represented on the plastic plates serve to modify the basic scene and can be interchanged to compare effects or can be designed to have an additive effect. This technique is very effective in comparing scenes, but can be quite costly when produced on a large scale. A series of photographs could present essentially the same information, however.

Maps can also be altered to represent changing conditions by the use of overlays or by a sequence of prints. Also, plans which increase or decrease the area of involvement can be represented on a map by variation in color shades.

Graphs can represent dynamic conditions. A series of graphs can be presented or a graph can be produced which changes from one condition to another with the manipulation of a lever. This allows a participant to adjust the graph to depict various combinations of conditions for comparison.

Games and models are inherently dynamic. Based on the type of plays a participant executes in a game, the progression and activity will change. Conditions in a game, therefore, vary with each play of the game.

Models are specifically created to indicate change through manipulation of parts. For mailable communications, changes in models must be depicted with photographs so the actual manipulation of the model is not in the control of the respondent.

For presenting forest management alternatives dynamic methods would generally be appropriate. Some ingenuity will be required, however, to achieve a dynamic presentation with basically "static" hard copy media. Sequences of photos, graphs, drawings, and/or written texts can present dynamic processes reasonably well.

Interactive/1-Way -- The purpose of the communication and the audience to which it is directed will help determine the extent to which a communication is interactive or one-way. If the communication is primarily to inform the audience of current or pending events, a one-way instrument will be appropriate. If, however, the goal is to involve them in a decision-making process, then interactive modes of communication should be employed.

Advertisements in newspapers, signs, or mailed out fliers or pamphlets can all serve well to inform an audience. Achieving interaction objectives through hard copy media is somewhat more difficult, however. The degree and extent of interaction, and often the contents of responses, can be predetermined by the designer of the communication. While the participant has some freedom in determining his input, he will be basically limited by what is in the communication. This suggests the need for careful development and pretesting to insure a format which allows the desired freedom of response from the public.

Frequently, the use of closed or precoded response formats (such as multiple-choice, true-false, and like-dislike rating scales) is desirable due to the relative ease of their completion and analysis. The interactive

quality of these methods can be enhanced by the way the respondent is asked to complete them. A relationship between questions can be provided by grouping them. For example, a respondent's answer to one question can determine what subsequent sections he/she will complete. This technique allows for flexibility of the instrument with the questionnaire tailored to the individual respondent. If the audience is relatively unsophisticated, however, this technique could lead to confusion in completing the appropriate sections.

Certain graphic techniques also lend themselves to interactive manipulation. Some of these techniques, however, are not appropriate for manipulation by the general public. For example, manipulation of photographs or drawings by the recipient would be difficult due to the artistic abilities required. It might be possible to provide the respondent with certain symbolic figures to arrange. As an example, a forest management plan might use symbols such as a tree to represent a specific amount of timber to be harvested and a man to represent employment for a certain number of people. The respondent would be asked to indicate his/her conception of an appropriate plan through the manipulation of these symbolic figures. A system would need to be devised to indicate possible combinations and trade-offs among these elements. The respondent might be presented with a simple map of a forest area and a selection of figures to affix to that map. With some stated restrictions, the respondent might place symbols on the map to indicate his judgment about where various activities should be emphasized or avoided.

Maps may also be directly altered by the respondent. Some drawing ability would be required, however, and members of the general public may not be capable of indicating their judgments accurately on a map. Also, this type of responding may be very difficult to analyze and quantify.

Graphs are also subject to interactive manipulation by the public. It is possible to present the respondent with a pair of axes and allow him/her to provide his/her own bar or line graph representing a desired combination of elements. Again, as with maps, some knowledge of scale and some degree of accuracy of response is required by this technique. Also, measurement and analysis of responses may prove time consuming and difficult.

Games and models lend themselves very well to interaction. Games are almost always interactive in that they require an individual to "play" the game. Models are interactive only if the participant is allowed to manipulate the model or simulation. If models or simulations must be presented in a hard copy format, their interactive capabilities will be substantially reduced. For example, if written descriptions or pictures are used to depict changes in a model, the respondent's reactions would generally be represented in a similar format. The interaction with the model or simulation then would be indirect, with no actual manipulation of the elements of the model.

Interactive techniques, in which the communication varies as a function of individual participants' inputs, are generally well received by the public. People enjoy the ability to manipulate things directly and feel that there is more freedom of expression. Many of the possible forms of hard copy communication may be made interactive and would be appropriate for audiences which vary along the interest and sophistication dimensions. The degree of difficulty and attractiveness may be varied in interactive forms in order to better suit the audience involved.

Simplicity/Complexity -- Any of the forms of communication may be varied along the simplicity/complexity continuum. It is possible to alter this quality in written passages, graphs, map detail, games, models,

and charts. The audience and content of the communication will determine the level at which the presentation will fall on this continuum. When the content of a communication is highly technical, it must be simplified for the majority of people who will be receiving it. This translation process requires care to assure that the simplified version retains the essential aspects of the original complex information. One means of determining whether the simple version accurately portrays the original information, is to ask uninvolved persons, who have the ability to understand the technical information, to judge whether the simple version accurately conveys the more complex ideas.

Progressive Presentation -- Since most communications will be directed at people who have varying levels of sophistication and interest, it may be helpful to employ a progressive presentation. The same information, for example, may be presented in three different versions. One version could summarize in relatively simple terms and require simple responses that take little time to complete. A second form may be geared to a more specific audience, such as special interest group members, who are capable and willing to pursue the subject in greater detail and of providing more detailed input. The presentations could be more complex in this case and the response formats could require more time and thought. And finally, a third version may be directed at experts who have the ability to assimilate the technical information and provide their own interpretations and reactions.

Combinations of Forms -- Combining several presentation techniques in a single communication is very desirable. The effectiveness of a graph can be enhanced by a good written presentation. A map frequently requires supplementary written or tabled information. These various methods complement each other, and the public is used to dealing with them in combination.

The combination of graphic techniques and prose is ubiquitous in public communications. Pictures, graphs, and maps provide a visual representation of principal points which can be accompanied by a written description that adds detail and qualifications. Some concepts can best be expressed visually and others in text but many concepts are most clearly presented in a combination of these modes.

Guidelines for the Selection of a Method of Presentation

The selection of a method for the presentation of information about forest management plans and the trade-offs associated with these plans involves a consideration of the relative appropriateness of the possible means of presentation. In this respect, the selection of a method of presentation is itself a trade-off problem. It is possible to present the information in a variety of ways, but considerations such as audience characteristics, the purpose of the communication, content of the communication, and cost of production make certain alternatives more desirable than others.

Cost -- An important consideration in choosing a presentation method is the budget. Some methods, such as photographic overlays, may require a rather large budget for production. Other techniques, such as games, require a substantial budget for the invention, development, and testing of the game. If it is necessary to obtain the services of extra artists or planners, costs will probably be substantially higher than when all work can be handled "in-house." Analysis and interpretation of responses also vary in cost due to the differing amounts of time and personnel required to code and interpret the data. A realistic estimate of the finances available and a consideration of the relative costs of the different methods will help in selecting the appropriate technique.

The most economical type of presentation is probably the written format. Slight cost increases will come with the introduction of graphic figures. The introduction of color printing will probably also have some effect on the cost of the production. The largest impact on costs will be for manipulable features, such as plastic overlays or movable graphs. Development costs will be highest for games and models. In some instances, methods that have higher costs may also be the most effective for presenting the information and soliciting responses. The relative costs, then, are but one consideration in selecting a communication method.

Length -- The communication should be the minimum acceptable size for presentation of the information. Very long communications (more than 10 pages) can significantly decrease the number of respondents. Increased length affects printing and mailing costs for the materials also. If in the development of a communication it is determined that a picture is really "worth a thousand words," then the picture should be used instead of 1,000 words of text. Similarly, other summary techniques such as charts, tables, graphs, and drawings are advantageous if they present the concept in a more concise form.

Audience -- In most cases it is difficult to identify characteristics which describe an audience. Pinpointing the interest and sophistication level of an audience is difficult, but the general characteristics of the audience can generally be approximated. Frequently, there will be considerable diversity within any audience.

If the specific sophistication level of an audience can be determined, the material to be presented can be aimed at the appropriate level of complexity. If the specific level is not known, and a single presentation is being produced, it is best to gear it toward the middle of the sophistication continuum. The best approach is to make progressive

presentation at several levels of complexity. This makes the material available at an advanced level, while not excluding the less sophisticated audience.

The interest level of the audience is also difficult to determine, but it is usually better to underestimate rather than assume high interest. The presentation itself should promote interest in the subject. Interest-arousing materials will serve to attract those who need the extra attraction, while not dissuading those who are already interested.

The communication can often be modified to address the interests of certain groups. If, for example, the recipient group is located in one county and the subject of the communication is a nearby forest, the importance of local issues can be stressed. Comments directed at groups interested in specific resources may also be appropriate to arouse interest. While these comments may be included in a general communication, they may be more effectively presented in an accompanying cover letter.

Conclusion

Communicating the technical basis of forest management alternatives is a difficult, but essential task. The public, however unsophisticated or disinterested, will be informed of and involved in all significant forest management decisions. This requirement presents an enormous problem of communication; a problem that contemporary technology is ill prepared to solve.

While treatises on the various modes and methods for communicating information are abundant, there is a significant lack of objective data regarding the relative effectiveness of different techniques. Is a pie-chart a more or less effective means than a bar graph for presenting forest management outcomes? Neither the existing literature nor this paper, which merely summarizes that literature, offers clear answers for

this or similar questions. Until systematic research is directed at such questions, forest managers and planners must continue to rely on their own intuitions and experiences to guide their communication efforts. For major efforts, "communications experts" might be consulted. In either event, there is considerable likelihood that communications will be too complex to be effective, or so simplistic as to fail to present an adequate basis for understanding the factors underlying the management decision. Some effort should always be made to follow up and to assess the effectiveness of any communication. Such efforts are particularly important if public response, based on the communication, is to influence the forest manager's decision.

COMMUNICATION BIBLIOGRAPHY

Beeby, A. W. & Taylor, H. P. J. How well can we use graphs? Communicator of Scientific and Technical Information, 1973, 17, 7-11.

Berry, Louis H. An investigation of the effectiveness of realistic and non-realistic color in visualized instruction. Paper presented at the Association for Educational Communications and Technology Annual Conference, Dallas, Texas, April 1975.

Bethke, D. D. Simple graphic techniques for the technical writer. In Procedings of the 25th International Technical Communication Conference, Dallas, Texas, May 1978, p. 32-35.

Carroll, P. How to Chart Data. New York: McGraw-Hill, 1960.

Cox, W. R. and Wong, P. A Graphic Display Method for Comparing Alternative Routes, USDA Forest Service, April 1978.

Dwyer, Francis M. Practical considerations in using visualized materials in the instructional development process. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology, Anaheim, CA, March - April 1976.

Ellison Joseph L. A comparison of the responses made to visual and to printed information by selected college students. Ed.D. Dissertation, East Texas State University, 1974.

Feliciano, G. D., Powers, R. D., and Kearl, B. E. The presentation of statistical information. AV Communication Review, 1963, 11, 32-39.

Funkhouser, G. Ray, and MacCoby, Nathan. Communicating specialized science information to a lay audience. Journal of Communication, Vol. 21, March 1971, p. 58-71

Huff, D. How to lie with statistics. London: Gollancz, 1967.

MacDonald-Ross, Michael. How numbers are shown. Audio-Visual Communication Review, Winter, 1977, 359-409.

Modley, R. and Lowenstein, D. Pictographs and graphs: How to make and use them. New York: Harper, 1952.

Navy Publications and Printing Service. Making the most of Charts, NAVPUB P-102, Nov. 1970.

Raims, Michael T., and Larson, David E. Graphics in Forestry: A Guide to Effective Display of Data. USDA, Forest Service, September 1978.

Suhr, Jim, Carder, D. Ross, and McKee, M. A Trade-off Evaluation Procedure, Draft. USDA, Forest Service, June 1979.

Williams, R. L. Statistical symbols for maps: Their design and relative values [contract NR 008-006 Nonr 609(03)]. Washington, DC: Office of Naval Research, 1956.

Wolfe, Mary L. The effect of format and organization on extrapolation and interpolation with multiple trend displays. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA, April 1976.

Wright, P. Presenting technical information: A survey of research findings. Instructional Science, 1977, 6, 93-134.

Wright, P. and Fox, K. Presenting information in tables. Applied Ergonomics, 1970, 1, 234-242.

Figure Captions

1. Comparison of standard narrative and comparative descriptions of two forest management plans.

2. Technical and simplified tables for displaying consequences of alternative management plans.

3. Comparison of two plans by means of "pie charts."

4. Use of realistic sketch to pictorially display information regarding forest management.

5. Use of cartoon sketch to communicate and stimulate reaction to forest pests.

6. Overlay or composite map compared to sequence of simpler maps.

7. Complex multiple functions graph compared to a series of simple graphs.

8. Combination of factor profile graphic and comparative description to communicate trade-offs among alternative management strategies.

9. Black-and-white photos of a manipulable three dimensional model.

Plan A

This plan offers a number of important benefits to the regional community. Because this plan allows for the effective utilization of the area's renewable timber resources, there will be an increase in wood industry based jobs providing a boost to the economies of local communities. While there will be some harvesting in an area being considered for wilderness designation, this will have only a small effect on wildlife and recreation opportunities in the area. Also, there will be more grass for livestock and more water runoff for rivers and reservoirs.

Plan B

This plan will reduce utilization of renewable timber resources and eliminate a number of wood industry related jobs in local communities. By designating a large area as wilderness, the opportunity for using timber and other renewable resources in the region will be lost. There will be no improvement in grasslands for livestock and no increase in water for rivers or reservoirs. Wilderness backpackers will benefit from this plan because of increased hiking trails and the restriction of access to the wilderness area.

Plan A

TIMBER production will be increased by selectively harvesting a larger percent of trees in each area. RANGE capacity will increase as forested lands are opened. WATER runoff will increase slightly. RECREATION will decrease due to the loss of a hiking trail in the unroaded area and the scenic impact of increased timber harvesting. WILDLIFE populations will decrease because non-game birds and mammals will lose some habitat. There will be an increase in wood industry based JOBS. The POTENTIAL WILDERNESS area will be harvested by selective cutting, as planned under current management.

Plan B

TIMBER production will decrease slightly. RANGE capacity and WATER runoff will remain unchanged from current management levels. RECREATION will increase due to additional hiking trails into the unroaded area and to several mountains and lakes. WILDLIFE populations will be maintained. Wood industry JOBS may decrease, but there may be some increase in recreation related income. The POTENTIAL WILDERNESS area will not be used for harvests or roads.

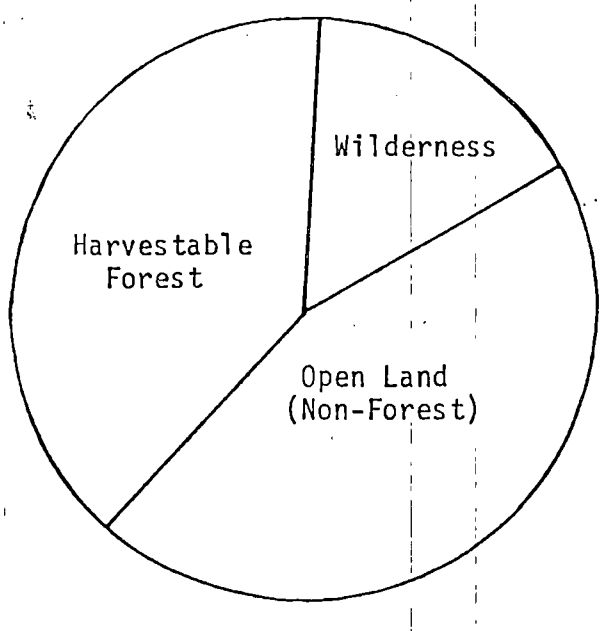
Fig. 2

FACTORS	UNITS	CURRENT MANAGEMENT	B	C	D
Sawtimber	MMBF	21	27	18	29
Pulpwood	1000 cords	17	25	15	25
Forage utilization	1000 AUMS	10	23	10	27
Water runoff	1000 acre-feet	48	48.5	48	49
Recreation use	1000 RVDs	50	55	60	55
	miles of hiking trails	55	42	135	42
Scenic beauty					
close-up vantage point	10 point scale	8	6	8	4
vista vantage point	10 point scale	8	6	8	6
Wildlife habitat					
deer	10 point scale	9	10	9	9
elk	"	9	9	9	9
Albert squirrel	"	7	5	7	2
turkey	"	10	9	10	9
timber searching birds	"	7	6	7	5
Economic effects					
Pineville area jobs	average full-time equivalent	589	706	576	798
MetroCity area jobs	average full-time equivalent	421	597	358	637
Net benefit	$1000 annuity at 5% discount rate	0	+463	-300	+950
Area of wilderness and potential wilderness	1000 acres	38.5	38.5	44.5	38.5

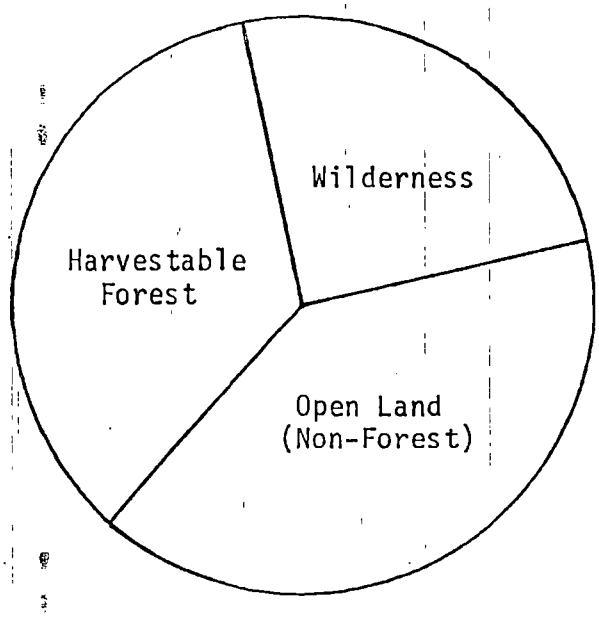
Factors	Plan B	Plan C	Plan D
Timber	++	-	++
Range	+	0	++
Water	+	0	+
Recreation	-	++	-
Wildlife	-	0	--
Jobs	+	-	++
Wilderness Potential	0	++	0

All changes are relative to current management

++ = substantial increase
+ = some increase
0 = no change
- = some decrease
-- = substantial decrease



PLAN A
Current Management



PLAN B
Extended Wilderness
Alternative

Natural Fuel Loadings in Ponderosa Pine and Mixed Conifer Forests of the Southwest

Stephen S. Sackett

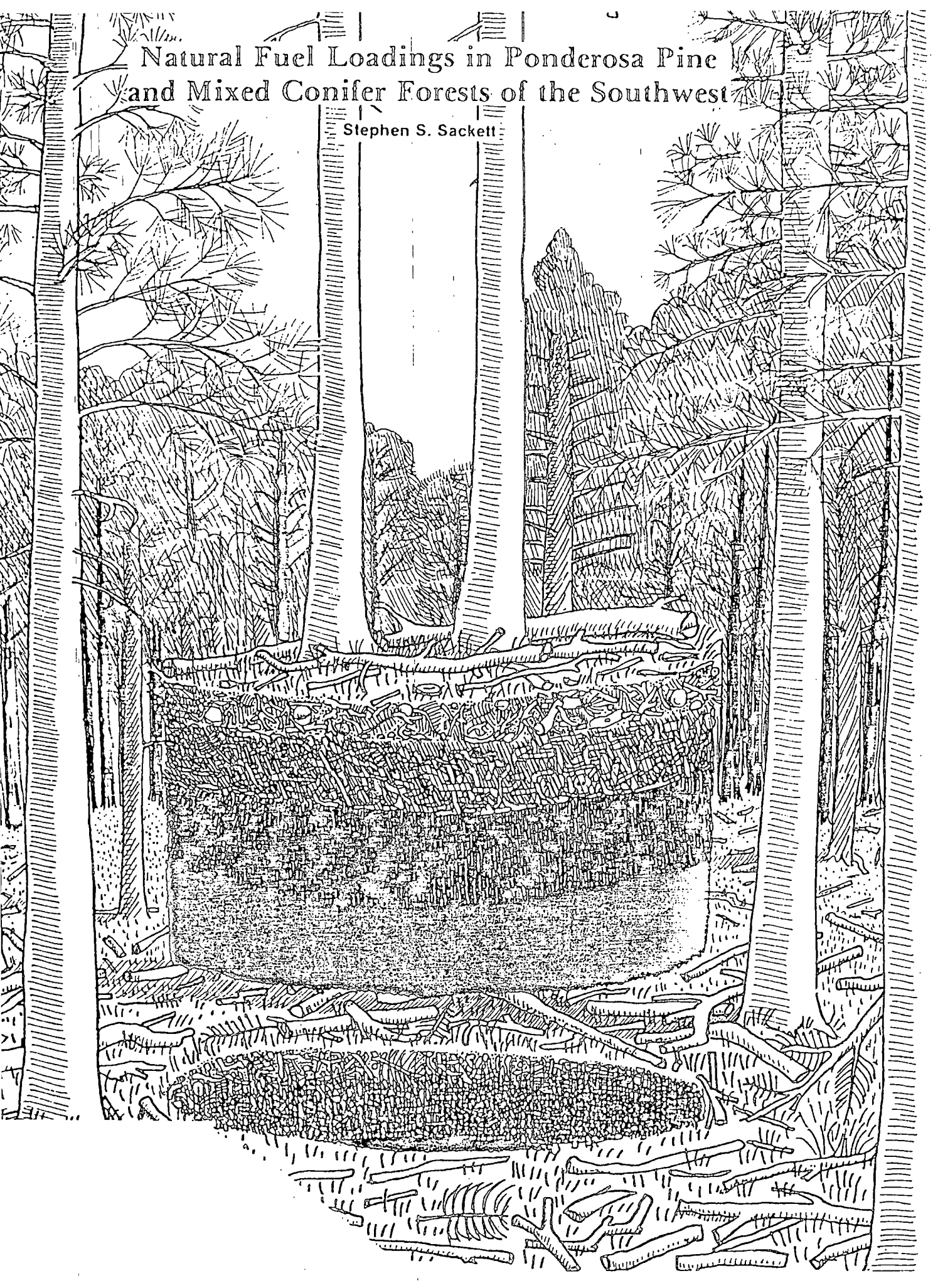
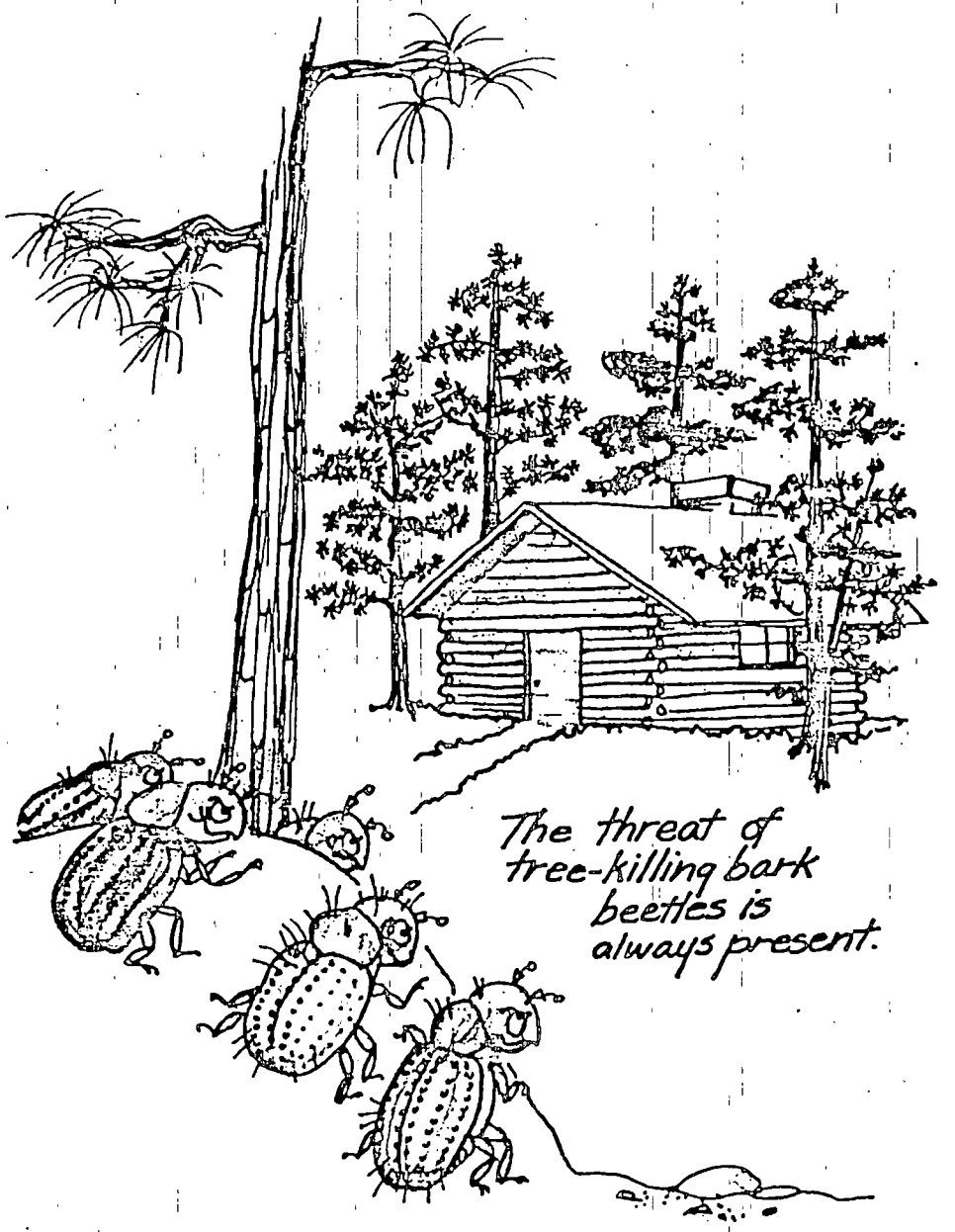
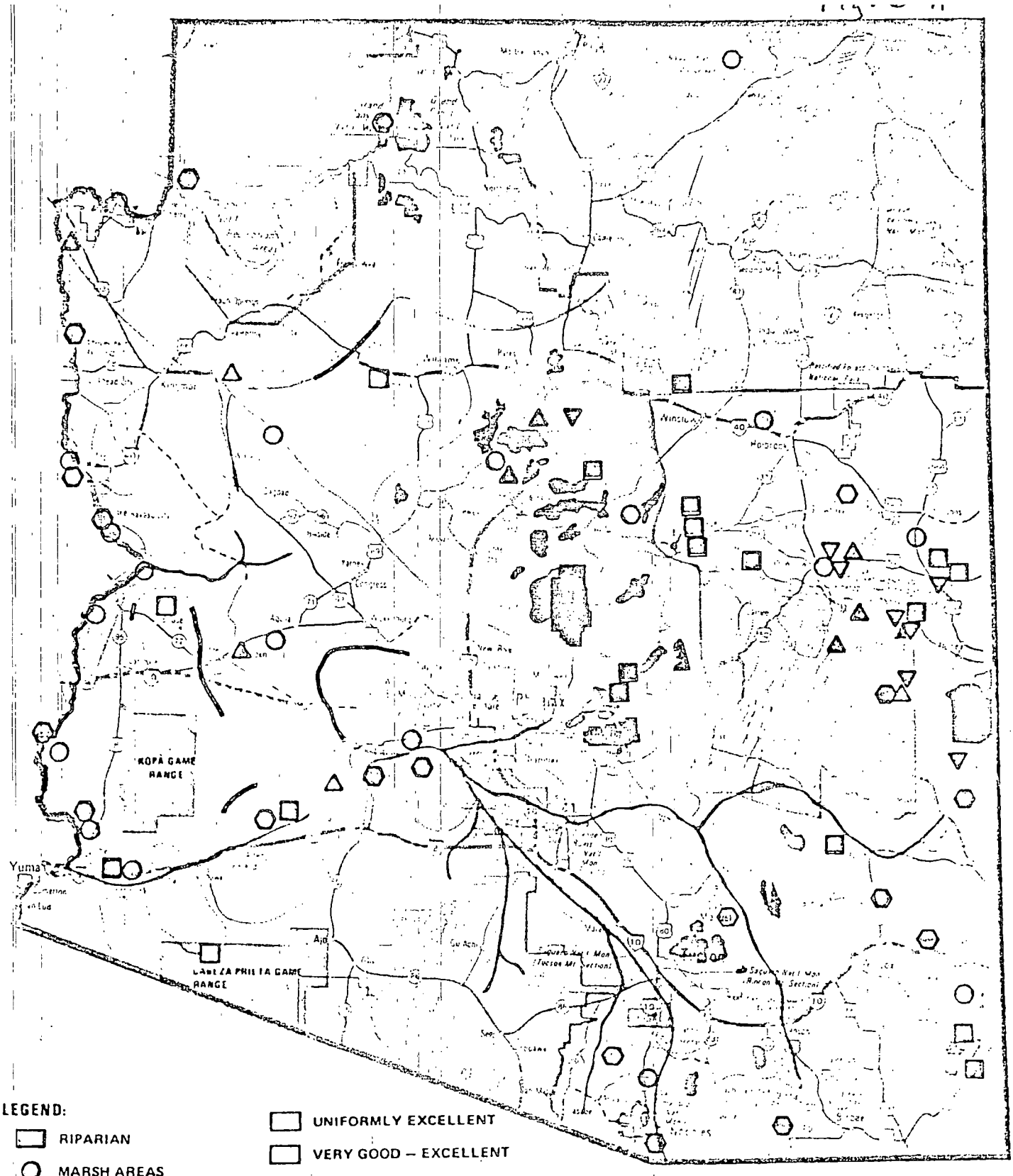


Fig. 5

Your pines may be in danger!



The threat of tree-killing bark beetles is always present.



LEGEND:

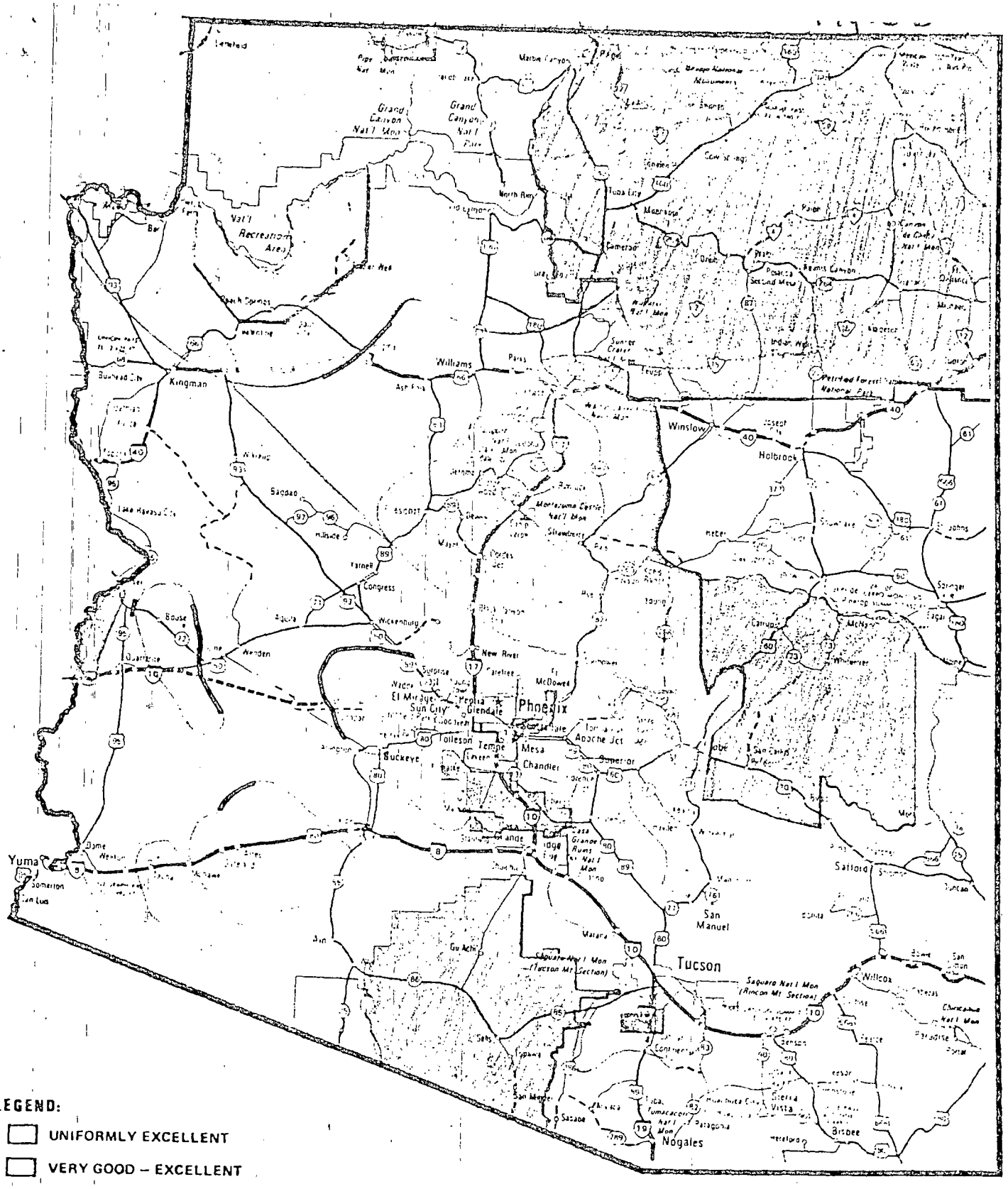
- RIPARIAN
- MARSH AREAS
- COTTONWOOD GROVES
- REMNANT GRASSLANDS
- MESQUITE THICKETS
- FISH HATCHERY
- FISH IMPROVEMENT AREAS
- REFUGE OR MANAGEMENT AREA – MAMMALS/GENERAL
- REFUGE OR MANAGEMENT AREA – BIRDS

- UNIFORMLY EXCELLENT
- VERY GOOD – EXCELLENT
- GOOD – VERY GOOD
- POOR
- GRAND CANYON BUFFER ZONE
- INDIAN LAND

- NATIONAL GAME RANGES
- WILDERNESS OR PRIMITIVE AREA
- INVENTORIED ROADLESS AREA

Meteorology/Air Quality

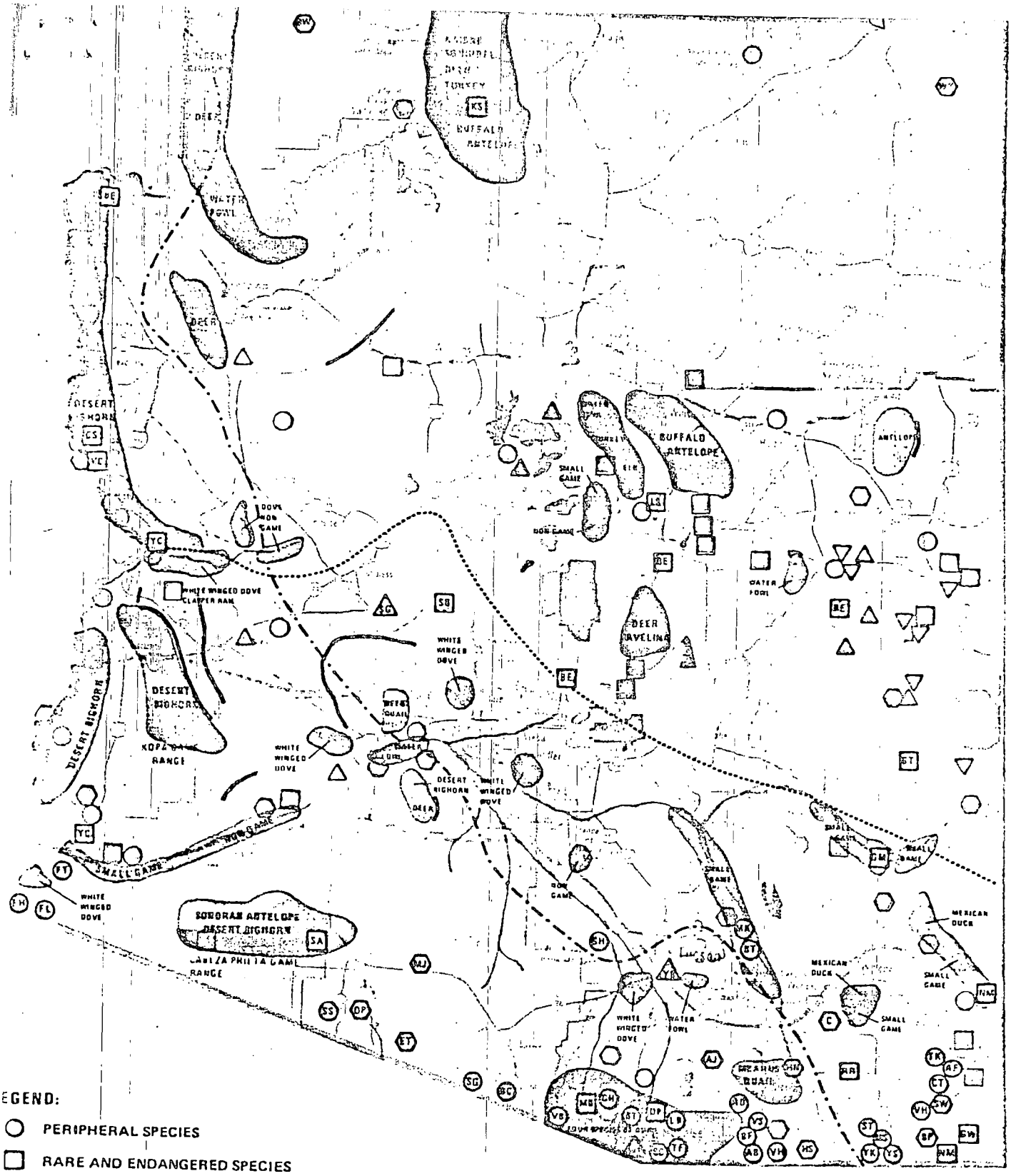
Ecological Considerations



LEGEND:

- UNIFORMLY EXCELLENT
- VERY GOOD – EXCELLENT
- GOOD – VERY GOOD
- POOR
- GRAND CANYON BUFFER ZONE
- INDIAN LAND

Meteorology/Air Quality



EGEND:

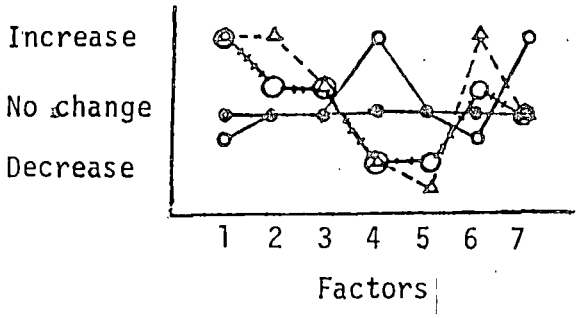
- ○ PERIPHERAL SPECIES
- □ RARE AND ENDANGERED SPECIES
- △ RESTRICTED RANGE SPECIES
- ⬡ SPECIES RESTRICTED TO A GENERAL AREA (but not a precise local)
- — DESERT BIGHORN SHEEP RANGE
- ..... WESTERN WHITE WINGED DOVE RANGE
- AREAS RECOMMENDED SPECIFICALLY FOR WILDLIFE
- NATIONAL MONUMENT WITH UNIQUE CACTUS

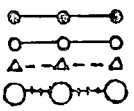
Ecological Considerations 2

Fig. 7

Factors

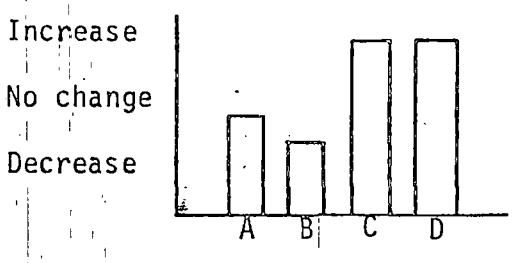
=Timber
=Range
=Water
=Recreation
=Wildlife
=Jobs
=Wilderness Potential



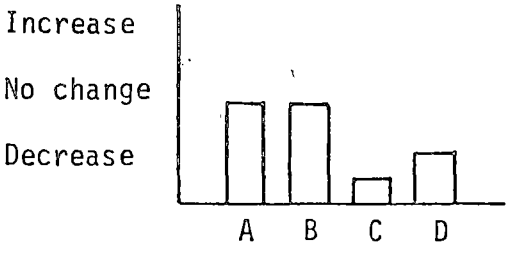


Plans
A (Current Management)
B
C
D

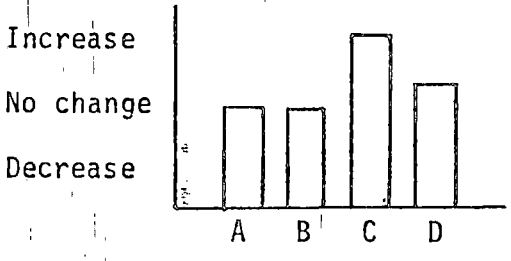
TIMBER



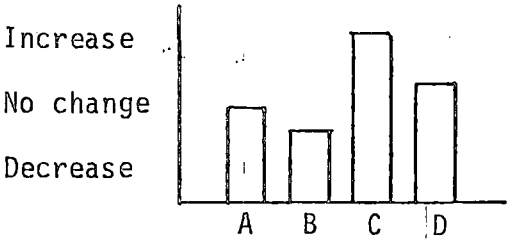
WILDLIFE



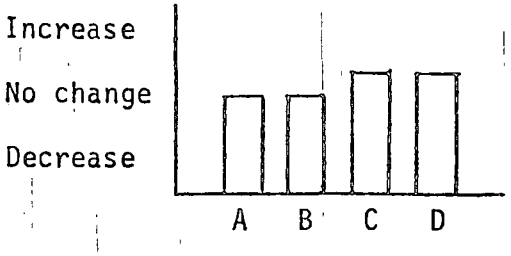
RANGE



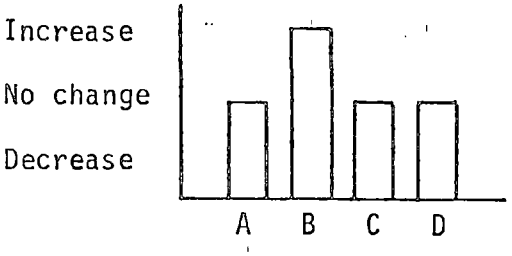
JOBS



WATER



WILDERNESS POTENTIAL



RECREATION

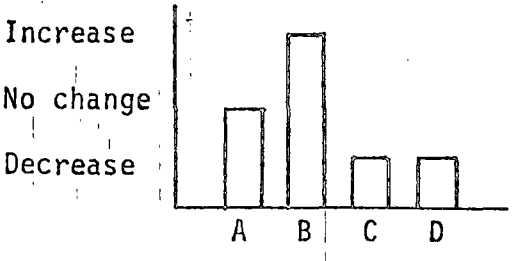
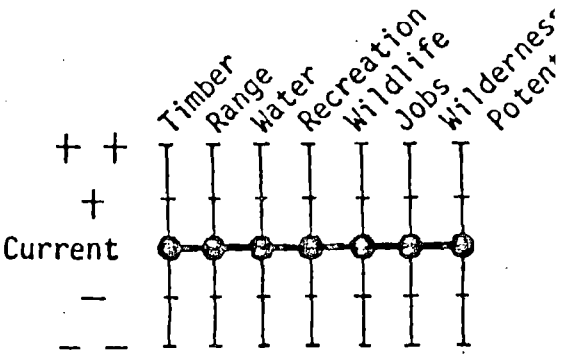


Fig. 8

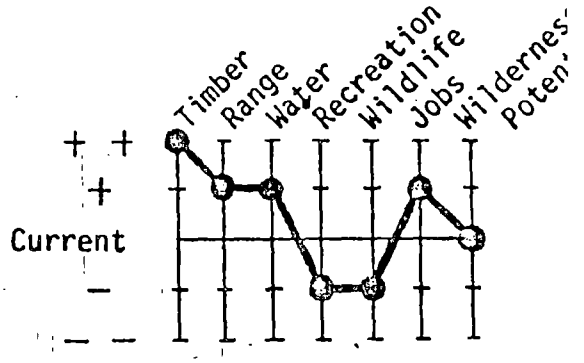
A - Continuation of Current Management

The current management practices for the forest were described on the preceding page. The factor profiles show changes from the current management approach; therefore, all the factors are at zero on this profile. In most cases, the "current" or zero point on the factor profile represents the current average annual yield for a particular factor. For the wilderness potential factor, the "current" point signifies the progressive harvesting of the unroaded area over the next forty years. The designated wilderness will remain as on the forest map.



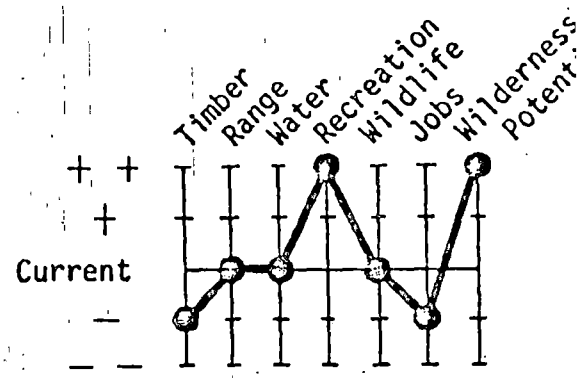
B

TIMBER production will be increased by selectively harvesting a larger percent of trees in each area. RANGE capacity will increase as forested lands are opened. WATER runoff will increase slightly. RECREATION will decrease due to the loss of a hiking trail in the unroaded area and the scenic impact of increased timber harvesting. WILDLIFE populations will decrease because non-game birds and mammals will lose some habitat. There will be an increase in wood industry based JOBS. The POTENTIAL WILDERNESS area will be harvested by selective cutting, as planned under current management.



C

TIMBER production will decrease slightly. RANGE capacity and WATER runoff will remain unchanged from current management levels. RECREATION will increase due to additional hiking trails into the unroaded area and to several mountains and lakes. WILDLIFE populations will be maintained. Wood industry JOBS may decrease, but there may be some increase in recreation related income. The POTENTIAL WILDERNESS area will not be used for harvests or roads.



D

TIMBER production will increase significantly over the next twenty years due to intensive selective cutting, and then decrease to approximately the present level. RANGE capacity will increase significantly as the forest lands are opened. WATER runoff will increase. RECREATION will decrease due to the loss of hiking trails in the unroaded area and the scenic impact of increased forest harvesting. WILDLIFE populations of non-game birds and mammals will decrease due to loss of habitat. There will be a significant increase in wood industry based JOBS for the next twenty years. The POTENTIAL WILDERNESS area will be harvested by selective cutting, as planned under current management.

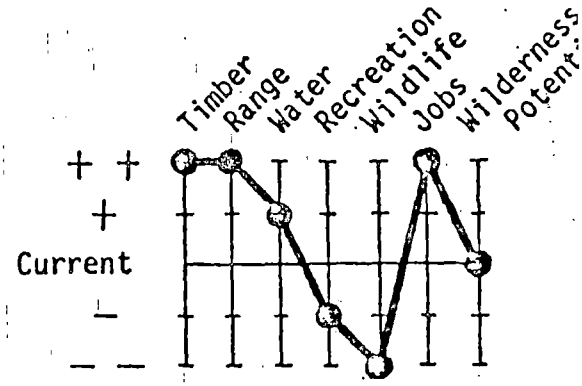
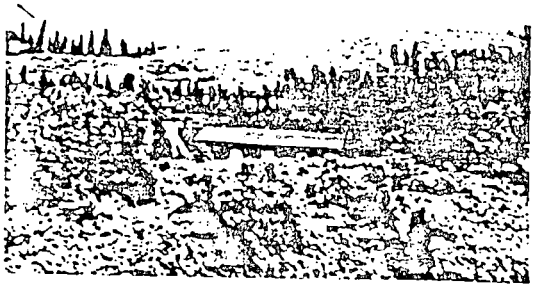
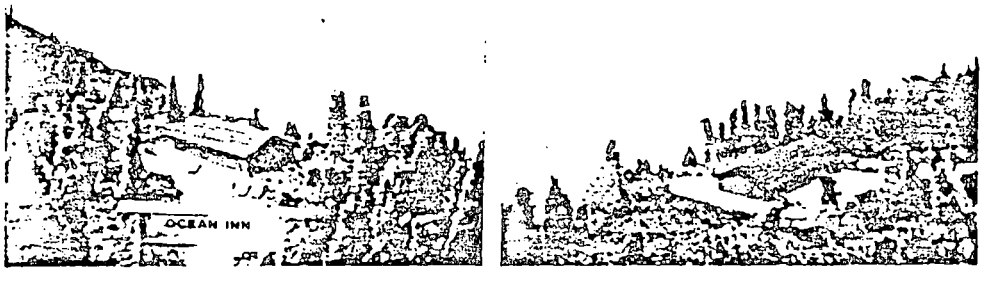
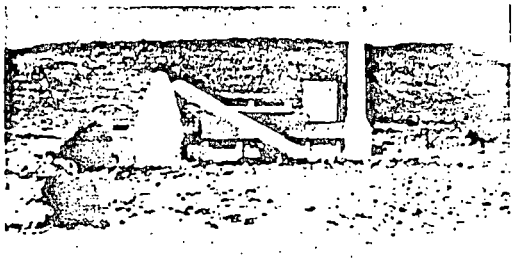


Fig. 9





Reproduction of slide-triad representing the "lodge" at the lowest level of contrast-obtrusiveness, in the "scenic" setting.



Reproduction of slide-triad representing the "factory at the highest level of contrast-obtrusiveness, in the "plain" setting.